Onchocerciasis of Queensland Cattle.

By Professor T. Harvey Johnston, M.A., D.Sc.,
University, Brisbane.

(Communicated by Professor Cleland, M.D.)

[Read October 13, 1921.]

In the present paper no less than three distinct species of *Onchocerca* are recorded as parasites of the connective tissues of Queensland cattle, *viz.*, *O. gibsoni*, Cleland and Johnston; *O. gutturosa*, Neumann; and *O. lienalis*, Stiles. A reference is also made to *O. fasciata*, Railliet and Henry, which infests camels.

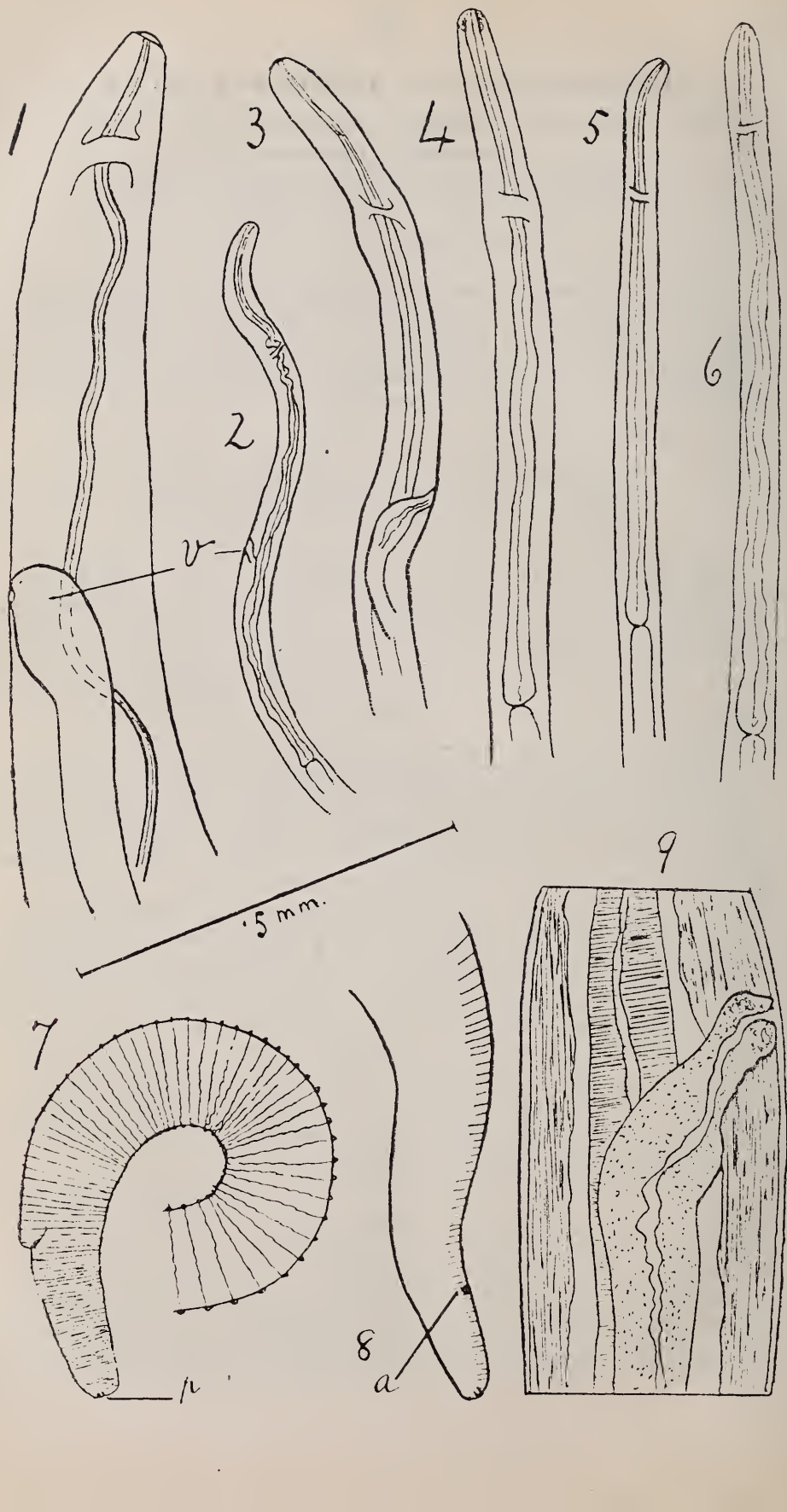
Onchocerca gutturosa, Neumann, 1910.

Figs. 3, 4, 7, 9, 10, 13, 16, 18, 19, 20, 25.

In a recent paper (Johnston and Bancroft, 1920a, p. 40) it was pointed out that, in addition to the well-known nodule-producing worm, *Onchocerca gibsoni*, a second species of the genus was to be met with in cattle in Queensland and New South Wales. It was provisionally identified as *O. bovis*, but shortly afterwards (J. and B., 1920b), in a summary of that paper, it was definitely labelled as belonging to Piettre's species.

In Australian cattle the parasite is to be found in the neck ligament between the first and fifth dorsal vertebrae; also at the level of the trochanter between the ends of the tendons which are attached in that region. The tendons at the stifle joint are also at times infected. Though a fibrosis is set up as a result of the presence of the parasite, yet the lesions are usually not extensive and do not assume the nodular form, so typical of *O. gibsoni* and *O. indica*. The worms occur more or less tangled lying in a fibrous tunnel, and considerable lengths of the female may be extracted from the surrounding fibrosed tissue before breaking takes place. Males lie loosely coiled or tangled in spaces adjacent to the females, or at a little distance, and can readily be obtained entire. Disintegrating worms undergoing calcification may be met with.

The writer has been informed that the parasite may be found in a very large percentage of cattle slaughtered at the Abattoirs in Brisbane and Rockhampton, so that it is, probably, very widely distributed in Queensland. It occurs, not uncommonly, in cattle slaughtered in Sydney. Mr. N. V. Brown, to whom I am indebted for specimens and information, informed me that he had not observed it in


1
2
3
4
5
6
v
·5 mm.
7
8
a
9

cattle killed in the Melbourne Abattoirs. Piettre (1912) recorded the presence of *O. bovis* in 26 out of 30 cattle examined in France, and in the cervical region of 65 per cent. to 70 per cent. of Argentine animals and of 90 per cent. of Uruguayan cattle killed at the meat preserving works in those two countries (Piettre, 1916; Joan, 1917). Emery (in Neumann, 1910, p. 270) reported that *O. gutturosa* was to be found in the connective tissue of the neck ligament, principally on the inner face, and especially at the level of the second and third dorsal vertebrae in Algeria and Tunis, where, he states, nearly all adult bovines harbour the parasite. It is worthy of note that Piettre (1912) failed to find *O. bovis* in the cervical ligament of French cattle, though he recorded it from the stifle joint and from the tibio-tarsal ligament.

We have not been able to determine the length of the female worm. Joan (1917, p. 448) gives it as being over 60 centimetres in Argentine specimens. Piettre found that in French specimens the total length of fragments exceeded 26 cm., while in Argentine worms (1916) it was about 70 cm.

Males (from Queensland cattle) measured from 24 to 33 mm. in length. Piettre gives 40 to 50 mm. in the case of French material. T. Joan mentioned that one of the males studied by her measured 57·5 mm.

Description of Female.

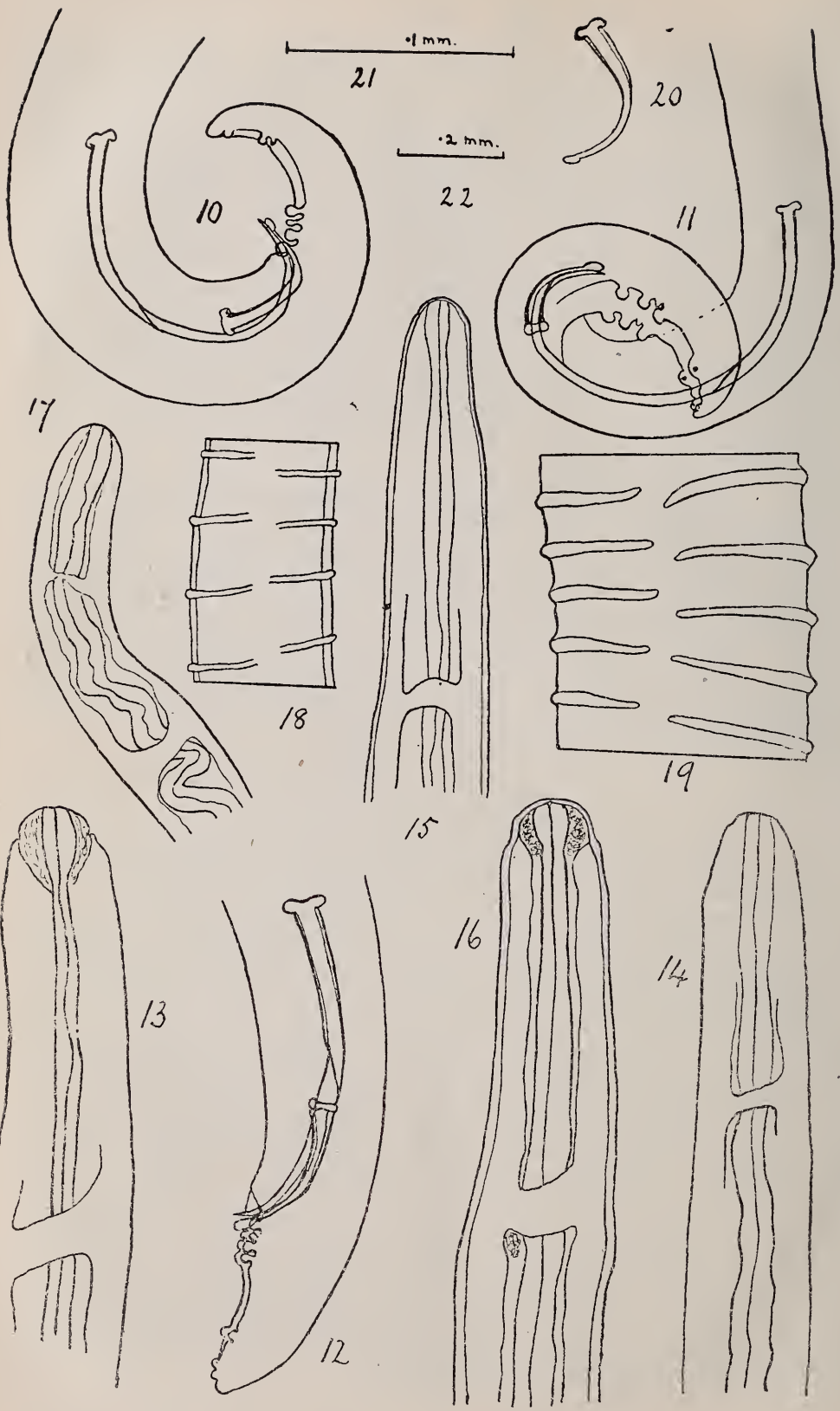
Figs. 3, 7, 9, 16, 18, 19, 25.

The female body tapers gradually towards the anterior end, but rather abruptly at the posterior extremity.

The head end (figs. 3, 16) is gently rounded in front and, at least in some specimens, appears to possess a few minute papillae. The cuticle is smooth as far back as the region of the termination of the long oesophagus. The width of the body in front of the nerve ring is from ·05 to ·06 mm. In the region of the latter there is a dilatation, so that the body measures ·07 to ·075 mm. in diameter. Behind this it narrows slightly to become again somewhat dilated at the level of the vagina, where the body diameter reaches ·070 to ·085 mm. The first (cervical) dilatation is situated at from

---

Figs. 1 to 3, heads of females. 1, *O. gibsoni*. 2, *O. lienalis*. 3, *O. gutturosa*. 4 to 6, heads of males. 4, *O. gutturosa*. 5, *O. gibsoni*. 6, *O. lienalis*. 7 and 8, female tails. 7, *O. gutturosa*. 8, *O. lienalis* (ridges only roughly and partly indicated). 9, part of *O. gutturosa*, showing female aperture. *a*, anus; *p*, papilla; *v*, vagina. Figs. 1 to 8, drawn to the scale indicated; 9, drawn about four times that scale.


·1 mm.
21
·2 mm.
22
20
10
11
17
18
15
19
13
12
16
14

·20 to ·25 mm. from the anterior end, while the second, *i.e.*, that in the vaginal region, occurs at ·50 to ·60 mm. from the mouth. At ·15 mm. from the anterior end, *i.e.*, in the region of the termination of the oesophagus, the body diameter is ·08 mm.

The posterior extremity (fig. 7) is strongly ringed to the tip. The anus lies at about ·22 mm. from the termination of the worm, the body width there being about 0·8 mm. Immediately in front of it the diameter is about ·1 mm. Behind the anus the body gradually tapers to end in a bluntly rounded tip with a diameter of about ·05 to ·06 mm. The end of the tail possesses a tiny rounded projection at its termination and there is a pair of very minute papillae situated rather on the ventral aspect in front of it. Joan detected one pair in Argentine specimens, and Neumann figured a pair in the Algerian species.

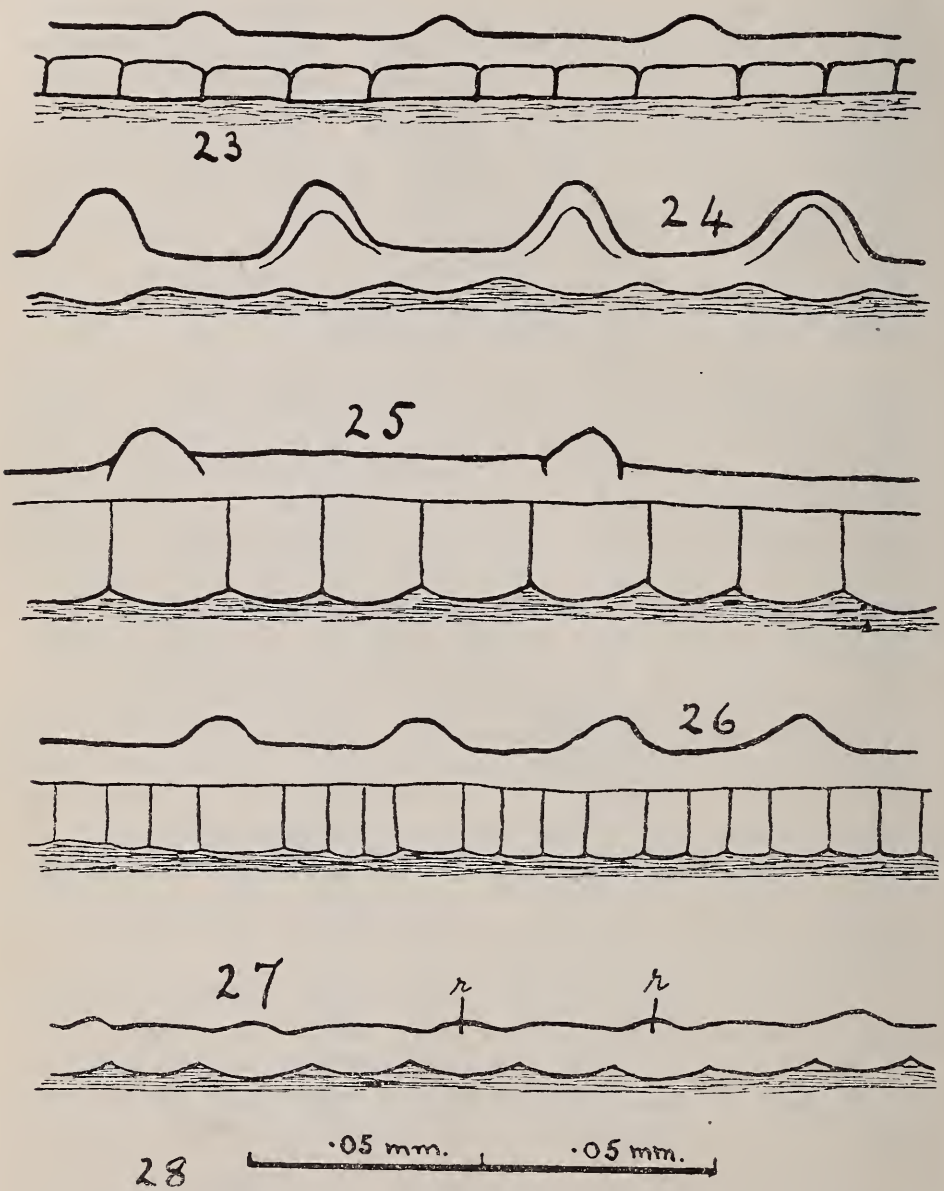
The body, except in the anterior region, is marked by well-developed spiral cuticular ridges, which vary in their prominence and closeness of arrangement according to the body region (figs. 18, 19). They are generally from 4 to 6 micra in height, but vary in width from 6 to 15 micra. The distances between the spirals increase with the body diameter. Thus, where the latter is about ·110 mm. the ridges are about 20 μ apart; when ·115 to ·120 mm., they are 25 to 35 μ apart (figs. 19, 26); ·130 mm., 30 to 45 μ apart; ·230 to ·250 mm., about 60 to 80 μ apart (fig. 25); when ·280 mm. (the maximum diameter of the female worm), the ridges are from 95 to about 120 μ distant (occasionally as much as 140 μ) from each other (fig. 18). At 3·5 mm. from the posterior extremity, the body diameter is ·26 mm. and the low ridges are ·07 mm. apart; at one millimetre from the tip the measurements are ·13 and ·03 respectively; and at ·5 mm. they are ·12 and ·01 respectively. The ratio of the distance between ridges on the mid-body to the diameter of the mid-body is from ·33 to ·43.

The ridges have a slight wavy outline owing to the presence of tiny prominences on them and, at first sight, seem to be arranged in a simple spiral, but they are at least on a great part of the body, apparently along the lateral lines (figs. 18, 19), interrupted in a manner somewhat like that

---

Figs. 10 to 12, tail ends of males. 10, *O. gutturosa*. 11, *O. lienalis*. 12, *O. gibsoni*. 13 to 15, heads of males. 13, *O. gutturosa*. 14, *O. lienalis*. 15, *O. gibsoni*. 16 and 17, heads of females. 16, *O. gutturosa*. 17, *O. lienalis*. 18 and 19, parts of body of female *O. gutturosa*. 18, body width, ·270 mm. 19, body width, ·120 mm. 20, small spicule of *O. gutturosa*. 21, scale to which figs. 10 to 17, 19, 20 were drawn. 22, scale for fig. 18.

figured (probably diagrammatically) by Joan for *O. bovis* (Argentine material), and exactly like that indicated by Neumann (1910, p. 275) for *O. gutturosa*. The arrangement of the ridges varies, then, according to the position from which they are viewed.



Figs. 23 to 27, views of side of females (optical section) to show thickness of cuticle, height of ridges, striae, etc.; all figs. drawn to scale indicated in fig. 28. 23, *O. fasciata* (diameter of body at place figured, ·41 mm.). 24, *O. gibsoni* (·50 mm.). 25, *O. gutturosa* (·230 mm.). 26, *O. gutturosa* (·120 mm.). 27, *O. lienalis* (·20 mm.); *r*, ridges.

The outer layer of the cuticle on the greater part of the female worm measures about 10 μ in thickness between the ridges. The underlying region is about 20 μ thick and is subdivided between each pair of ridges, usually into three (occasionally four) ring-like segments and there is one below each ridge (figs. 25, 26). From the apex of one ridge to that of the next one there are, then, three complete and two half rings of the under-cuticle, just as figured by Neumann. Thus there appear four striae between the ridges. Joan (p. 447) figures eight such secondary annulations and nine striae as occurring between the main ones, the latter being 127 μ apart and the former 15·5 μ. In our specimens the secondary rings measured from 7 to 10 μ (the main rings, *i.e.*, those below the ridges, being rather wider than those intervening), when the ridges were 45 μ apart; and about 20 μ in width when the summits of the ridges were 95 μ distant from each other.

The mouth is immediately followed by the long tubular oesophagus, about 1·52 mm. long and measuring from 12 to 18 μ in diameter in front of the nerve-ring and 22 to 25 μ behind it. Surrounding the anterior end of the oesophagus there is a mass of cells which appear to be glandular. The intestine does not call for comment.

As already stated, the position of the nerve-ring corresponds with the anterior dilatation of the body and lies at about 220 to 240 μ from the mouth. The excretory pore appears to be situated in this region. The thick-walled vagina opens at the level of the second dilatation, about ·50 to ·57 mm. from the anterior extremity of the worm (fig. 9). Uterine eggs, containing fully-developed larvae, have very thin shells and measure 32 to 37 μ in their major diameter and 23 to 30 μ in their minor axis. Larvae found free in the uteri have a length of about ·20 mm. and a breadth of 5 μ, the anterior end being bluntly rounded and the posterior pointed.

Description of the Male.

Figs. 4, 10, 13, 20.

The male worm maintains a comparatively even diameter throughout, being ·05 to ·06 mm. in front of the nerve-ring which lies at ·18 to ·20 mm. from the anterior end, gradually widening to ·08 to ·09 mm., and maintaining the latter breadth until near the posterior extremity. At the level of the anus the diameter is ·04 mm., the worm gradually tapering to the tip. The anterior dilatation in the vicinity of the nerve-ring is very slight, the diameter of the parasite there being about ·065 mm. The second dilatation of the

female is not represented. A few tiny papillae appear to be present at a little distance behind the mouth. Cuticular ornamentation is hardly recognizable even under the oil immersion. The cuticle is very delicate, measuring about 2·5 to 3 μ in thickness.

The anterior end (figs. 4, 13) resembles that of the female, as also does the oesophagus, which has a similar diameter (10 to 12 μ), but the length is ·82 to 1·1 mm. The anus lies at ·075 to ·085 mm. from the tip of the spirally coiled tail.

The male papillary arrangement is usually as follows (fig. 10): four pair of perianal, of which the third pair are often rather smaller than the others; a post anal group of two, consisting of a smaller anterior papilla, lying just in front of, or beside, a larger one; and a caudal group composed of a prominent double one formed by the fusion of the pair (*i.e.*, one from each side), and there may, at times, be recognized a very small papilla on each side in front of it. The alae are rather narrow.

The longer spicule has an obliquely pointed end and measures from ·180 to ·255 μ in length, the breadth being 5 to 7 μ, while the shorter spicule is a thicker organ terminating in an enlarged rounded extremity. The shorter measures ·060 to ·080 mm. (generally about ·070) in length and 7 to 10 μ in maximum breadth (excluding the anterior expanded rim-like portion), its form tapering posteriorly so that the width is about 3 μ just in front of the widened extremity, which is about 5 μ across and 10 μ long (fig. 20).

If the information relating to this Australian species and *O. gutturosa* from Northern Africa, contained in the accompanying tables be compared, it will be noticed in regard to the males, that practically all the measurements agree except the lengths of the greater spicule, Neumann's maximum being longer than our maximum. In the case of the females the agreement is practically complete, the only marked differences being in regard to the diameters of the oesophagus and the cervical dilatation, these being of minor importance. It seems best to regard the Australian parasites as *O. gutturosa*, including under its synonymy *O. bovis*, Johnston and Bancroft, 1920 (*nec* Piettre, 1912). A specimen collected from an ox in Sydney Abattoirs and placed at our disposal through the kindness of Dr. E. W. Ferguson, Health Department, Sydney, was found to be specifically identical with the Queensland material.

The information available to the writer regarding *O. bovis*, Piettre, from French cattle is not sufficient to allow him to compare it with *O. gutturosa*. The site of infection

varies, the latter being especially common in the neck ligaments, whereas the former is reported by Piettre as not invading that region. Neumann makes no reference to the presence of his species in any other location, but there is no evidence that it was looked for elsewhere. Piettre recorded *O. bovis* as occurring in the femora-tibial (stifle) joint of French cattle. The male of *O. bovis* is much longer and the female probably much shorter than those of *O. gutturosa*. The lengths of the male spicules, in the former, correspond with those of Australian specimens, but are less than those given by Neumann for *O. gutturosa*. In our earlier account it was mentioned that the female parasites were very like those of the Algerian species, but that the dimensions of the male spicules agreed with those of Piettre's species, hence our earlier determination. It must be left for some other investigator to determine whether Piettre's and Neumann's species are distinct.

The brief account (Joan, 1917) available regarding the South American parasite allows one to note certain differences from the Australian species. The males in the former are much longer and the papillae are said to be differently arranged, but in view of the difficulty sometimes experienced in detecting them, especially when the tail is closely rolled up, and in view of the variations in position (especially asymmetrical development) known to occur in the genus *Onchocerca*, further examination might reveal additional papillae. The South American female worms are recorded as being much longer than the French *O. bovis*, but agree more nearly with Neumann's account. The maximum diameter of the body and also the distance between the spirals are given as being about twice as great as in Algerian and Australian specimens. Besides, there are figured from six to nine striae between the ridges, whereas in the other cases there are from three to five. The egg is distinctly larger in both diameters, though not as large as given by Piettre for those of the French species.

It seems likely that the South American parasite is not *O. bovis*, but the available description does not allow one to synonymise it with *O. gutturosa*. The lesions and site of infection are similar to those of the Australian worm, as also are those briefly described by Ransom (1920, 1921), who reported that an *Onchocerca* occurred commonly in cattle slaughtered in Chicago. Whether the latter is *O. gutturosa* or the South American species has not been settled, though Piettre recorded as *O. bovis* parasites collected from frozen beef from Madagascar, Canada, and the United States.

ONCHOCERCA LIENALIS, Stiles, 1892.

Figs. 2, 6, 8, 11, 14, 17, 27.

In the former account (Johnston and Bancroft, 1920) mention was made that "*O. bovis*" was to be met with in Queensland cattle in the gastro-splenic ligament, and it was suggested that the species was probably identical with Piettre's. Recent examination shows them to be quite distinct.

O. lienalis is extremely common in cattle in this State, especially in dairying districts in the south-eastern portion of it. It has been stated to me that nearly 100 per cent. of cows and bulls and perhaps 50 per cent. of oxen slaughtered are found to harbour this parasite whose presence in Australia had not previously been noted. In the Rockhampton district the worm is very common, but apparently less so than in the south-eastern part of the State. Mr. N. V. Brown has informed me that it is commonly met with in cattle in New South Wales.

The female nematode is readily overlooked owing to its location in the connective tissue, between the stomach and the spleen, especially adjacent to the latter, where the tunnel enclosing the parasite, if noticed, would easily be mistaken for an empty blood-vessel. The organism lives in a very delicate worm-like fibrous tunnel in the connective tissue, this tunnel showing no tendency to become thickened except occasionally at the tail end of the worm. There is then comparatively little fibrosis and no typical nodule formation as the parasite does not roll itself up in the tissues, except sometimes at the extreme posterior end, where coiling may occur and a slight local thickening of the tissue become noticeable. A female specimen, measured *in situ*, reached 316 mm., while another (also *in situ*), whose extreme anterior end was missing, was 425 mm. long, its estimated length being 460 mm. Usually only two or three worms seem to occur in each host. Though every female examined (from about 25 different hosts) contained uterine larvae, in only one case was a male obtained.

As the worm has never been described, it seems advisable to place on record some data regarding it. Stiles named it *Filaria lienalis*, in 1892, from cattle in United States of America, but the description was lost during transit. In 1894 he referred to the parasite as *Spiroptera reticulata*. Both Leiper and Gedoelst, in 1911, placed it under *Onchocerca*.

Description of the Female.

The anterior end of the female is extremely delicate (figs. 6, 17) and it is a matter of chance whether one succeeds

in obtaining the head. As only one such specimen was collected, the measurements are necessarily based on it and do not indicate any range of variation. The head end is bluntly rounded, and almost at once assumes a diameter of ·03 mm., reaching ·04 at the level of the nerve-ring (·16 mm. from the mouth). The increase in diameter is so gradual that at 40 mm. from the mouth it is only ·05 mm. Ultimately the width reaches a maximum of ·18 to ·20 mm. Towards the posterior end it tapers to about ·16 mm. (at ·6 mm. from the tip), then rather more quickly towards the tail (fig. 8). At the level of the anus (which lies at ·13 mm. from the tip) the diameter is ·065 mm. The extremity is bluntly rounded and possesses a pair of very minute papillae. *In situ* the tail end is sometimes found spirally rolled and lying in a little gland-like mass of fatty and fibrous tissue, but often occurs lying in line with the preceding part of the body.

The ridges in this species are irregularly wavy and extremely low, their greatest height being under two micra (fig. 27). In the mid-region of the worm they are fairly regularly situated at ·030 to ·040 mm. apart. In the tail region they are very low and close. At ·6 mm. from its tip they measured ·015 to ·017 mm. apart (body width ·16 mm.). Between two adjacent ridges there are two striae and, sometimes, these latter are sufficiently pronounced to make it difficult to distinguish them from the low ridges, and then that portion of the worm seems to be minutely corrugated. The ratio of the distance between adjacent ridges on the mid-body, to the mid-body diameter, is only ·2 as against ·33 to ·4 in the case of *O. gutturosa*, and about ·08 to ·10 in *O. gibsoni*, where they are especially close.

The oesophagus is ·75 mm. long, its diameter increasing from ·015 to ·02 mm. as it proceeds posteriorly. The vagina lies at ·48 mm. from the anterior extremity.

Description of the Male.

The male is a very delicate organism, apparently inhabiting serous spaces in the connective tissues, not surrounded by a tunnel—in this respect resembling the male of *O. gutturosa*. The only specimen obtained—a broken one—measures 23·8 mm. in length and possesses an even diameter (·05 mm.) for nearly the whole of its length; narrowing gradually to the spirally-wound tail, the width at the cloaca being ·03 mm. It is worthy of note that the head end has, practically, the same dimension as that of the female.

The head (figs. 6, 14) is rounded and bears at least two, probably four, tiny papillae. Lips are not recognizable.

The annulations, though very minute and closely arranged, are readily visible under the high power. The cloaca lies at ·06 mm. from the tip of the tail. The nerve-ring is situated at ·13 from the mouth. The oesophagus has a width of ·018 mm., increasing to ·025 mm.

The alae are very narrow. There are four pair of perianal papillae, the first, second, and fourth pairs being large, the third quite small and situated rather inwardly from the remainder. The postanal pair are very prominent and there seems to be a tiny pair inwardly from, and just behind, them. There is a pair of large caudal papillae, very close together. The spicules are of the usual *Onchocerca* form, measuring ·240 and ·057 mm. in length, and ·006 and ·009 mm. in width, respectively (fig. 11).

Ransom (1920, 1921) sated that *O. lienalis* is common and widely distributed in the United States. It appears to be a parasite of no economic importance.

Onchocerca gibsoni, Cleland and Johnston, 1910.

Figs. 1, 5, 12, 15, 24.

The common worm-nodule producer *O. gibsoni*, occurring in cattle in Queensland, New South Wales, and the Northern Territory, has been described so often that there is little need to do more than call attention to a few points in structure in order that they may be compared with similar parts in the other two cattle-frequenting species under review. Most of these particulars are referred to in the accompanying tables.

O. gibsoni (female) is a much stouter parasite than the other two and its spiral ridges are much more pronounced, being considerably higher and with better developed prominences along the course of the spirals. The male of *O. gibsoni* is also a rather larger parasite, its minimum equalling the maximum of *O. gutturosa*, and its cuticle is distinctly ornamented, ridges being indicated even on the tail.

The ridges in the female were found to be usually situated at from ·05 to ·08 mm. apart in the mid-body where the diameter was about ·45 mm. The maximum height was from 12 to 15 micra. Between adjacent ridges there could be seen, in favourable preparations, two fairly well-marked striae, 25 to 30 micra apart (fig. 24).

The nerve-ring in the female figured lies at ·12 to ·15 mm., and the vagina at ·7 mm. from the anterior end. Both of these organs vary somewhat in regard to their positions in relation to the anterior end.

As already pointed out by Dr. Sweet, the male may possess a large papilla situated well in front of the cloaca. In a favourable preparation, generously placed at my disposal by Dr. Ferguson, such a preanal pair is followed by three perianal pairs, a well-marked postanal, and a caudal group of three pairs—one being a large precaudal pair, followed by two smaller pairs, close to the tip of the tail—making a total of eight pairs.

The amount of fibrosis of the surrounding connective tissues of the host seems to be related to the development of ridges on the parasite, there being extremely little fibrosis surrounding *O. lienalis*, whose ridges are very low; a greater amount surrounds *O. gutturosa*, and, at times, there may be a slight indication of nodule formation, while the strongly corrugated forms, like *O. gibsoni*, *O. indica*, *O. fasciata*, and *O. volvulus*, give rise to a well-marked nodule formation.

Onchocerca fasciata, Railliet and Henry, 1910.

Fig. 23.

Attention was drawn by Dr. Cleland and the author, in 1910, to the presence of a worm nodule-producing *Onchocerca* (identified as being perhaps *O. gibsoni)* in camels imported from India into Western Australia. In the same year Railliet and Henry (C.R. Soc. Biol., 68, 1910, p. 250) gave the species the above name, describing it as follows:—Female alone known from fragments without extremities; thickness, 400 to 475 micra; cuticle with slightly undulating ridges, repeated at every two or three striae; from a subcutaneous nodule from the head of a dromedary, Punjab. [The host was incorrectly listed by Dr. Sweet (1915, p. 31) as *Camelus bactrianus*.]

In our original account (1910, pp. 177, 178, 189) we mentioned that the anterior end and body fragments of the female specimens, examined by us, showed similar characters and measurements to those of *O. gibsoni*, and that the vulva was similarly placed.

A re-examination of some fragments, collected by Prof. Cleland from Western Australia, and now in the writer's collection, shows that the maximum body diameter is from ·40 to ·45 mm., and that the irregularly sinuous and knobbed ridges are from ·07 to ·09 mm. apart (fig. 23). Between the ridges are two to four, usually three, striae. The ridges are from 7 to 9 micra in height on the mid-body. The larval measurements resemble those of *O. gibsoni*, *viz.*, length ·18 to ·20 mm., and breadth ·003 mm.

TABLE SHOWING COMPARATIVE DATA RELA
The figures in parentheses are based on measurements obta
(relating to *O. gibsoni)* are taken from Dr. Sweet's p

FEMALES.

	O. gutturosa, Australia.	*O. bovis* France (Piettre)
Length of female	?	260+
Diameter ·15 mm. from anterior end ...	·08	
Diameter just in front of vulva	·07-·085	
Diameter of mid-body	·250-·280	·26-·29
Diameter at level of anus	·08-·10	
Diameter of cervical dilatation	·07-·075	
Nerve-ring from anterior end	·22-·24	
Oesophagus, length	1·52	·82-·85
Oesophagus, diameter	·012-·018	
Vulva from anterior end	·55-·60	·63-·65
Anus from posterior end	·22	
Cuticle thickness	·030	
Distance between spiral ridges on mid-body	·095-·120	
Ratio of distance between adjacent ridges on mid-body to maximum diameter of mid-body	·33-·43	
Number of striae between ridges	4	3
Height of ridges on mid-body	·004-·006	
Egg (with larva), length	·032-·037	·048-·053
Egg (with larva), breadth	·023-·030	·034-·036
Free larva, length	·20	·230-·265
Free larva, breadth	·005	·0055

MALES.

	O. gutturosa, Australia.	*O. bovis* France (Piettre)
Length of male	24-33	40-50
Diameter ·15 mm. from anterior end ...	·05-·06	
Diameter ·5 mm. from anterior end	·05-·06	
Diameter of mid-body	·08-·09	·085-·095
Diameter of level of cloaca	·03-·04	
Diameter cervical dilatation	·065	
Nerve-ring from anterior end	·18-·22	
Oesophagus, length	1·1	·750-·800
Oesophagus, diameter	·010-·020	
Cloaca from posterior end	·075-·085	
Long spicule, length	·180-·255	·180-·210
Short spicule, length	·060-·080	·065-·075
Long spicule, diameter	·005-·007	
Short spicule, diameter	·007-·010	
Transverse ridges apart	·0015	·005-·006
Papillae (adanal, postanal, caudal)	4, 2, 1 or 2	4, 1, 2

(1) In our original short account (Agric. Gaz., N.S. Wales, 1
is a typograp

-HOCERCA, SPP. SIZES IN MILLIMETRES.
ne authors' drawings (Joan, Piettre), while those in brackets
pp. 44, 46), compiled from the work of various authors.

FEMALES.

bovis, entine n and ttre),	*O. gutturosa*, N. Africa.	*O. lienalis*, Queensland.	*O. gibsoni.*	*O. fasciata.*
-700+	550+	316-(460 ?)	[526-1403]	?
06)	(·072)-·081	·04	[·049]-·13	
10)	(·09)	·04	[·106-·207]	
508	·30	·18-·20	[·37-·5]	·40-·475
170)	(·07)	·065	[·175-·245]	
030)	·09-·10	Absent	Absent	
27)	(·28)	·16	[·102-·188]	
262	1·15	·75-1·1	[·52-1·42]	
004)	(·036)	·015-·02	[·017-·052]	
60)	·55	·43-·48	[·33-1·138]	
·30)	·20	·13	[·175-·402]	
023)	·035-·047	·020	[·007-·01]	·012-·015
209	·090-·110	·040	·05-·08	·07-·09
·24)	(·33-·37)	·2	·11-·13	·10
6-9)	3-5	2	2	2-4 (3)
	(·006)	·002	·012-·015	(·006-·009)
8-·042	·035-·045	·038-·040	[·04-·045]	
1-·035	·028-·035	·028-·030	[·03-·039]	
	·170-·195	·240	[·22-·35]	·18-·23
	·004	·004	[·003-·004]	·003

MALES.

bovis, gentine oan).	*O. gutturosa*, N. Africa.	*O. lienalis*, Queensland.	*O. gibsoni.*	*O. fasciata.*
57·5	28·3-33·8	23·8	[33-55]	Male not yet known
·032)		·05	·038-[·066]	
	·35 (? ·035)	·05	·061-[·085]	
·09	·09-·105	·052	·12-[·196]	
·03)	0·58	·03	[·035-·056]	
?	·08	Absent	Absent	
	(·35)	·13	[·14-·20]	
	·95	·90	[·48-1·07]	
·01)		·018-·025	[·015-·07]	
057)		·060	[·048-·087]	
216	·225-·295	·240	[·140-·220]	
·078	·075-·088	·057	[·063-·094] (1)	
·005)	(·01)	·006	[·005-·014]	
·005)	(·015)	·009	[·005-·008]	
	·0015-·0018	·002	[·0045-·006]	
text), 0, 2	4, 2, 1	4, 1 (? 2), 1	4, 1, 2 (3)	

orter spicule was reported to be ·047 mm. in length. This
for ·074 mm.

TABLE SHOWING COMPARATIVE DATA RELATING TO ONCHOCERCA, SPP. SIZES IN MILLIMETRES.

The figures in parentheses are based on measurements obtained from the authors' drawings (Joan, Piettre), while those in brackets (relating to *O. gibsoni*) are taken from Dr. Sweet's paper 915, pp. 44, 46), compiled from the work of various authors.

FEMALES.

	O. gutturosa, Australia.	*O. bovis*, France (Piettre).	*O. bovis*, Argentine (Joan and Piettre),	*O. gutturosa*, N. Africa.	*O. lienalis*, Queensland.	*O. gibsoni.*	*O. fasciata.*
Length of female	?	260+	600+-700+	550+	316-(460 ?)	[526-1403]	?
Diameter ·15 mm. from anterior end ...	·08		(·06)	(·072)-·081	·04	[·049]-·13	
Diameter just in front of vulva	·07-·085		(·10)	(·09)	·04	[·106-·207]	
Diameter of mid-body	·250-·280	·26-·29	·508	·30	·18-·20	[·37-·5]	·40-·475
Diameter at level of anus	·08-·10		(·170)	(·07)	·065	[·175-·245]	
Diameter of cervical dilatation	·07-·075		(·030)	·09-·10	Absent	Absent	
Nerve-ring from anterior end	·22-·24		(·27)	(·28)	·16	[·102-·188]	
Oesophagus, length	1·52	·82-·85	1·262	1·15	·75-1·1	[·52-1·42]	
Oesophagus, diameter	·012-·018		(·004)	(·036)	·015-·02	[·017-·052]	
Vulva from anterior end	·55-·60	·63-·65	(·60)	·55	·43-·48	[·33-1·138]	
Anus from posterior end	·22		(·30)	·20	·13	[·175-·402]	
Cuticle thickness	·030		(·023)	·035-·047	·020	[·007-·01]	·012-·015
Distance between spiral ridges on mid-body	·095-·120		·209	·090-·110	·040	·05-·08	·07-·09
Ratio of distance between adjacent ridges on mid-body to maximum diameter of mid-body	·33-·43		(·24)	(·33-·37)	·2	·11-·13	·10
Number of striae between ridges	4	3	(6-9)	3-5	2	2	2-4 (3)
Height of ridges on mid-body	·004-·006			(·006)	·002	·012-·015	(·006-·009)
Egg (with larva), length	·032-·037	·048-·053	·038-·042	·035-·045	·038-·040	[·04-·045]	
Egg (with larva), breadth	·023-·030	·034-·036	·031-·035	·028-·035	·028-·030	[·03-·039]	
Free larva, length	·20	·230-·265		·170-·195	·240	[·22-·35]	·18-·23
Free larva, breadth	·005	·0055		·004	·004	[·003-·004]	·003

MALES.

	O. gutturosa, Australia.	*O. bovis*, France (Piettre).	*O. bovis*, Argentine (Joan).	*O. gutturosa*, N. Africa.	*O. lienalis*, Queensland.	*O. gibsoni.*	*O. fasciata.*
Length of male	24-33	40-50	57·5	28·3-33·8	23·8	[33-55]	Male not yet known
Diameter ·15 mm. from anterior end ...	·05-·06		(·032)		·05	·038-[·066]	
Diameter ·5 mm. from anterior end	·05-·06			·35 (? ·035)	·05	·061-[·085]	
Diameter of mid-body	·08-·09	·085-·095	·09	·09-·105	·052	·12-[·196]	
Diameter of level of cloaca	·03-·04		(·03)	0·58	·03	[·035-·056]	
Diameter cervical dilatation	·065		?	·08	Absent	Absent	
Nerve-ring from anterior end	·18-·22			(·35)	·13	[·14-·20]	
Oesophagus, length	1·1	·750-·800		·95	·90	[·48-1·07]	
Oesophagus, diameter	·010-·020		(·01)		·018-·025	[·015-·07]	
Cloaca from posterior end	·075-·085		(·057)		·060	[·048-·087]	
Long spicule, length	·180-·255	·180-·210	·216	·225-·295	·240	[·140-·220]	
Short spicule, length	·060-·080	·065-·075	·078	·075-·088	·057	[·063-·094] (1)	
Long spicule, diameter	·005-·007		(? ·005)	(·01)	·006	[·005-·014]	
Short spicule, diameter	·007-·010		(? ·005)	(·015)	·009	[·005-·008]	
Transverse ridges apart	·0015	·005-·006		·0015-·0018	·002	[·0045-·006]	
Papillae (adanal, postanal, caudal)	4, 2, 1 or 2	4, 1, 2	(3 in text), 0, 2	4, 2, 1	4, 1 (? 2), 1	4, 1, 2 (3)	

(1) In our original short account (Agric. Gaz., N.S. Wales, 1910) the shorter spicule was reported to be ·047 mm. in length. This is a typographical error for ·074 mm.